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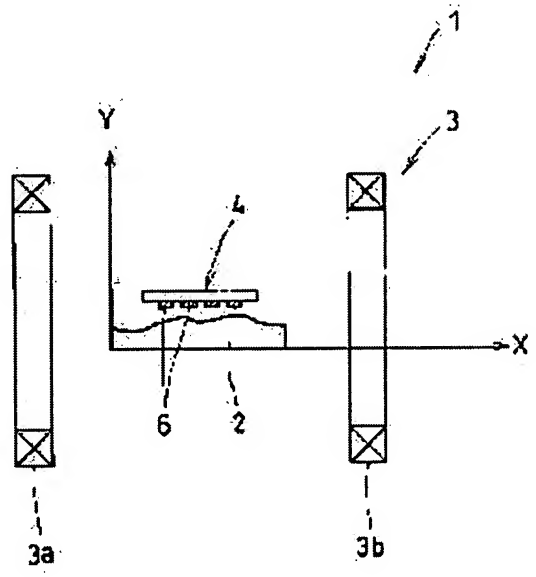
(54) METHOD, SENSOR AND APPARATUS FOR DETECTION OF SURFACE SHAPE, METHOD AND APPARATUS FOR DISCRIMINATION OF COIN, METHOD AND APPARATUS FOR DETECTION OF SURFACE DEFECTS AND VISUALIZATION APPARATUS FOR SURFACE SHAPE

(57)Abstract:

PROBLEM TO BE SOLVED: To detect the surface shape of a specimen composed of a conductor with satisfactory accuracy.

SOLUTION: The method is provided and an AC magnetic-field generation process, in which an AC magnetic field nearly parallel to the surface of the specimen 2 is generated and a magnetic-flux-change detection process in which a change in a magnetic flux, in a direction nearly parallel to the magnetic field is detected near the surface of the specimen 2. The apparatus is provided with an AC magnetic-field generation device, by which the AC magnetic field nearly parallel to the surface of the specimen 2 is generated and a surface-shape detection sensor 4 by which the change in the magnetic flux in the direction nearly parallel to the magnetic field is detected near the surface of the specimen 2.



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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the surface-discontinuity test equipment and the surface-type-like visualization equipment which were further equipped with the coin discernment approach using said surface-type-like detection approach, the coin identification unit equipped with said surface-type-like detection equipment, the surface-discontinuity inspection approach using said surface-type-like detection approach, and said surface-type-like detection equipment about the surface-type-like detection approach, the surface-type-like detection sensor, and the surface-type-like detection equipment which detect the shape of surface type of a conductor.
[0002]
[Description of the Prior Art] In recent years, the method (equipment) of detecting the shape of surface type of the analyte which consists of a conductor by non-contact is developed variously. These detection approaches are used in the field of for example, a coin identification unit, surface-discontinuity test equipment, surface type-like visualization equipment, etc., and it is requested strongly that the detection precision is raised. It is divided roughly into the thing using an optical means, and the thing using a magnetic means as the above-mentioned detection approach. An analyte front face is photoed using a CCD sensor as the optical detection approach. Although what carries out the image processing of the photography data, and specifies the shape of surface type, and the thing which receives the reflected light on the front face of analyte with light-receiving devices, such as photo diode, and specifies the shape of surface type based on the light-receiving level are known If it is in the optical detection approach, since not **** that is easy to receive effect in the dirt on the front face of analyte but concavo-convex height and the concavo-convex depth are undetectable, only the two-dimensional detection data containing dirt are obtained, but there is inconvenience to which the application is limited. What, on the other hand, uses the eddy current effectiveness of the conductor in an alternating current field as the magnetic detection approach is known. an eddy current bars change of the magnetic flux which pierces through a conductor, when conductors, such as a metal, are put on an alternating current magnetic field -- as -- a conductor -- since it generates inside and the generating condition changes according to the shape of surface type of a conductor, it becomes possible by detecting the flux reversal by the eddy current near the front face of a conductor to detect the shape of surface type of a conductor.
[0003]
[Problem(s) to be Solved by the Invention] However, in the above-mentioned conventional thing, near the front face of analyte, an exiting coil and a sensing coil are arranged so that the direction of the coiling heart may be perpendicularly suitable to an analyte front face. In order for the above-mentioned sensing coil to detect the flux reversal in the near, generating a vertical alternating current field to an analyte front face with this exiting coil, The shape of surface type needed to be specified based on the slight flux reversal resulting from height change (depth change) of the irregularity in an analyte front face, and the limitation was in the detection precision.
[0004]
[Means for Solving the Problem] the approach of detecting the shape of surface type of the analyte which this invention created for the purpose of solving these technical problems in view of the actual condition like the above becomes from a conductor -- it is -- the front face of said analyte -- abbreviation -- the front face of said analyte the alternating current field generating process of generating an parallel alternating current field, and near -- said field -- abbreviation -- it is characterized by to have the flux-reversal detection process of detecting the flux reversal of the parallel sense. that is, the front face of analyte -- abbreviation -- an eddy current is intensively generated by generating an parallel alternating current field on the side face of the irregularity which exists on the surface of analyte -- making -- the generating situation of this eddy current -- said field -- abbreviation, in order to detect as flux reversal of the

parallel sense Compared with the former which it became possible to detect the irregularity on the front face of analyte clearly, consequently had detected the slight flux reversal based on a concavo-convex height change, detection precision can be raised by leaps and bounds. moreover, said flux reversal detection process -- said analyte -- the front face -- abbreviation -- it is characterized by performing making it move in the parallel direction. In this case, since the shape of surface type of analyte is scanned, things can be carried out and, moreover, the structure of surface type-like detection equipment can be simplified by [which specify the shape of surface type of analyte by few flux reversal sensing elements] moving an analyte side at the time of detection. moreover, said flux reversal detection process -- the near front face of said analyte -- said field -- abbreviation -- the flux reversal sensing element which detects the flux reversal of the parallel sense -- the front face of said analyte -- abbreviation -- it is characterized by performing making it move in the parallel direction. In this case, since the shape of surface type of analyte is scanned, since [which specifies the shape of surface type of analyte by few flux reversal sensing elements] a flux reversal sensing element side is moved at the time of detection, moreover, the shape of surface type of an anchorage is also detectable [things can be carried out, and]. Moreover, said flux reversal detection process is characterized by performing in two or more detection locations by which one-dimensional array was carried out in the direction which carries out an abbreviation rectangular cross to the migration direction of said analyte, or the migration direction of a flux reversal sensing element, and meets the front face of said analyte. In this case, two-dimensional detection data can be obtained by the flux reversal sensing element by which one-dimensional array was carried out. Moreover, said flux reversal detection process is characterized by performing in the detection location of a large number by which two-dimensional array was carried out in the direction along the front face of said analyte. In this case, since the shape of surface type of analyte can be detected without scanning, the detection error resulting from the migration error of analyte or a flux reversal sensing element can be avoided, and detection precision can be raised. moreover, the sensor which detects the shape of surface type of the analyte which this invention created for the purpose of solving these technical problems in view of the actual condition like the above becomes from a conductor -- it is -- the front face -- abbreviation -- it arranges near [where the parallel alternating current field was generated] the front face of analyte -- having -- said field -- abbreviation -- it is characterized by having the flux reversal sensing element which detects the flux reversal of the parallel sense. In the analyte in which the parallel alternating current field was generated that is, a front face -- abbreviation -- the side face of the irregularity which exists in the front face -- an eddy current -- intensive -- generating -- the generating situation of this eddy current -- said field -- abbreviation, in order to detect as flux reversal of the parallel sense Compared with the conventional surface type-like detection sensor which can detect the irregularity on the front face of analyte clearly, consequently detects the slight flux reversal based on a concavo-convex height change, detection precision can be raised by leaps and bounds. Moreover, said flux reversal sensing element is characterized by being arranged to the front face of said analyte at abbreviation parallel. in this case, the front face of analyte -- abbreviation -- the detection precision of flux reversal can be raised by being arranged to the front face of analyte at abbreviation parallel, and detecting the flux reversal of the parallel sense by the flux reversal sensing element. Moreover, said flux reversal sensing element is characterized by carrying out one-dimensional array in the direction along the front face of said analyte. In this case, two-dimensional detection data can be obtained by moving analyte or a flux reversal sensing element in the abbreviation rectangular cross direction to the array direction of a flux reversal sensing element. Moreover, said flux reversal sensing element is characterized by carrying out two-dimensional array in the direction along the front face of said analyte. In this case, since the shape of surface type of analyte can be detected without scanning, the detection error resulting from the migration error of analyte or a flux reversal sensing element can be avoided, and detection precision can be raised. Moreover, said flux reversal sensing element is characterized by being a coil, a chip inductor, a hall device, or a magnetic resistance element. In this case, a surface type-like detection sensor can be constituted using the existing magnetic device. Moreover, said flux reversal sensing element is characterized by having the core formed in the shape of continuation, and two or more coils wound around this core by consisting in predetermined spacing, and being constituted. In this case, not **** that can manufacture efficiently two or more magnetic variation sensing elements by which one-dimensional array was carried out but components mark and production processes can be reduced, and a large cost cut can be aimed at. moreover, the equipment which detects the shape of surface type of the analyte which this invention created for the purpose of solving these technical problems in view of the actual condition like the above becomes from a conductor -- it is -- the front face of said analyte -- abbreviation -- the front face of said analyte an alternating current field generating means generate an parallel alternating current field, and near -- said field -- abbreviation -- it is characterized by to have a flux-reversal detection means detect the flux reversal of the parallel sense. that is, the front face of analyte -- abbreviation -- an eddy current is intensively generated by generating an parallel alternating current field on the side face of the irregularity which exists on the surface of analyte -- making -- the generating situation of this eddy current -

- said field -- abbreviation, in order to detect as flux reversal of the parallel sense Compared with the former which it became possible to detect the irregularity on the front face of analyte clearly, consequently had detected the slight flux reversal based on a concavo-convex height change, detection precision can be raised by leaps and bounds. Moreover, said flux reversal detection means is characterized by being the flux reversal sensing element arranged to the front face of said analyte at abbreviation parallel. in this case, the front face of analyte -- abbreviation -- the flux reversal of the parallel sense is arranged to abbreviation parallel to the front face of analyte -- having -- flux reversal ****** The detection precision of flux reversal can be raised by detecting by the child. Moreover, said flux reversal detection means is characterized by being two or more flux reversal sensing elements by which one-dimensional array was carried out in the direction along the front face of said analyte. In this case, two-dimensional detection data can be obtained by moving analyte or a flux reversal sensing element in the abbreviation rectangular cross direction to the array direction of a flux reversal sensing element. Moreover, said flux reversal detection means is characterized by being the flux reversal sensing element of a large number by which two-dimensional array was carried out in the direction along the front face of said analyte. In this case, since the shape of surface type of analyte can be detected without scanning, the detection error resulting from the migration error of analyte or a flux reversal sensing element can be avoided, and detection precision can be raised. Moreover, said flux reversal detection means is characterized by being a coil, a chip inductor, a hall device, or a magnetic resistance element. In this case, a surface type-like detection sensor can be constituted using the existing magnetic device. Moreover, said flux reversal detection means is characterized by having the core formed in the shape of continuation, and two or more coils wound around this core by consisting in predetermined spacing, and being constituted. In this case, not **** that can manufacture efficiently two or more magnetic variation sensing elements by which one-dimensional array was carried out but components mark and production processes can be reduced, and a large cost cut can be aimed at. Moreover, this invention created for the purpose of solving these technical problems in view of the actual condition like the above The surface type-like detection process of being the coin discernment approach using the surface type-like detection approach given in any of claims 1-5 they being, and detecting the shape of surface type of a coin using said surface type-like detection approach, The detected surface type-like data are matched with the reference pattern set up beforehand, and it is characterized by having the coin discernment judging process of identifying said coin based on the hit ratio. That is, since a coin is identified based on surface type-like data with a high precision detected using said surface type-like detection approach, the discernment precision of a coin can be raised. Moreover, this invention created for the purpose of solving these technical problems in view of the actual condition like the above It is the coin identification unit equipped with surface type-like detection equipment given in any of claims 12-17 they are. The surface type-like data of the coin detected using said surface type-like detection equipment are matched with the reference pattern set up beforehand, and it is characterized by having a coin discernment means to identify said coin based on the hit ratio. That is, since a coin is identified based on surface type-like data with a high precision detected using said surface type-like detection equipment, the discernment precision of a coin can be raised. Moreover, this invention created for the purpose of solving these technical problems in view of the actual condition like the above The surface type-like detection process of being the surface-discontinuity inspection approach using the surface type-like detection approach given in any of claims 1-5 they being, and detecting the shape of surface type of analyte using said surface type-like detection approach, The detected surface type-like data are matched with the reference pattern set up beforehand, and it is characterized by having the surface-discontinuity judging process of judging the surface discontinuity of said analyte based on the hit ratio. That is, since the surface discontinuity of analyte is judged based on surface type-like data with a high precision detected using said surface type-like detection approach, the judgment precision of surface discontinuity can be raised. Moreover, it is surface-discontinuity test equipment equipped with surface type-like detection equipment given in any of claims 12-17 they are, and the surface type-like data of the analyte detected using said surface type-like detection equipment are matched with the reference pattern set up beforehand, and it is characterized by having a surface-discontinuity judging means to judge the surface discontinuity of said analyte based on the hit ratio. That is, since the surface discontinuity of analyte is judged based on surface type-like data with a high precision detected using said surface type-like detection equipment, the judgment precision of surface discontinuity can be raised. Moreover, this invention created for the purpose of solving these technical problems in view of the actual condition like the above is surface type-like visualization equipment equipped with surface type-like detection equipment given in any of claims 12-17 they are, and is characterized by to have a signal-transformation means change into the status signal of a display the surface type-like data of the analyte detected using said surface type-like detection equipment. That is, since the shape of surface type of analyte is displayed based on surface type-like data with a high precision detected using said surface type-like detection equipment, the shape of surface type of analyte can be displayed with a sufficient precision. [0005]

[Embodiment of the Invention] Next, one of the gestalten of operation of this invention is explained based on a drawing. In a drawing, 1 is surface type-like detection equipment which detects the shape of surface type of the analyte 2 which consists of a conductor. This surface type-like detection equipment 1 the front face of analyte 2 -- abbreviation -- with the alternating current field generator (alternating current field generating means) 3 made to generate an parallel alternating current field the near front face of analyte 2 -- said field -- abbreviation -- it has the surface type-like detection sensor (flux reversal detection means) 4 which detects the flux reversal of the parallel sense, and actuation and a detecting element 5 including the actuation circuit of the alternating current field generator 3, and the detector of the surface type-like detection sensor 4, and is constituted.

[0006] The alternating current field generator 3 is equipped with the exiting coils 3a and 3b of the couple arranged by consisting in predetermined spacing. Excitation actuation is carried out by the AC signal, and the exiting coils 3a and 3b of a couple generate an alternating current field between both coil 3a and 3b. Analyte 2 is placed between both coil 3a and 3b so that the front face may become said field and abbreviation parallel. The alternating current field generated by abbreviation parallel on the front face of analyte 2 makes the side face (an inclined plane is included) of the irregularity which exists in the front face of analyte 2 generate an eddy current intensively, and the flux reversal by this eddy current is detected by the surface type-like detection sensor 4.

[0007] The surface type-like detection sensor 4 is equipped with the flux reversal sensing element 6 which detects flux reversal, and the substrate 7 which supports this flux reversal sensing element 6, and is constituted. The coil wound around others, a ferrite core, and an amorphous core as a flux reversal sensing element 6, the chip inductor of a coil type, a hall device, a magnetic resistance element, etc. can be used. [air cored coil / which is adopted with this operation gestalt]

[0008] Drawing 2 is the side elevation of the flux reversal sensing element which consisted of air cored coils. As shown in this drawing, the flux reversal sensing element 6 constituted using an air cored coil is equipped with the core 8 formed with a fused quartz, the polar zone 9 formed in the ends heights of this core 8 by performing plating etc., and the coil 10 by which it is wound around the above-mentioned core 8, and those ends are electrically connected to the polar zone 9, is constituted, is carried out as a simple substance component or two or more elements, and is used. the flux reversal sensing element 6 is arranged near the front face of analyte 2 so that the direction of the coiling heart may be said alternating current field and abbreviation parallel and it may become the front face of said analyte 2, and abbreviation parallel -- having -- said alternating current field -- abbreviation -- the flux reversal of the parallel sense is detected.

[0009] (A) of drawing 3 is the top view of the surface type-like detection sensor by which one-dimensional array of the flux reversal sensing element was carried out. Surface type-like detection sensor 4A shown in this drawing carries out one-dimensional array of two or more flux reversal sensing elements 6, and is constituted. In predetermined spacing, it consists and one-dimensional array of each flux reversal sensing element 6 is carried out so that the direction of the coiling heart may become said alternating current field and abbreviation parallel, and it is electrically connected to a substrate 7. When detecting the shape of surface type of analyte 2 using this surface type-like detection sensor 4A, it performs moving analyte 2 or surface type-like detection sensor 4A in the array direction of the flux reversal sensing element 6 in the direction which carries out an abbreviation rectangular cross. It becomes possible to scan the shape of surface type of analyte 2, and to obtain two-dimensional detection data by this, by the flux reversal sensing element 6 by which one-dimensional array was carried out.

[0010] (B) of drawing 3 is the top view of the surface type-like detection sensor by which two-dimensional array of the flux reversal sensing element was carried out. Surface type-like detection sensor 4B shown in this drawing carries out two-dimensional array of two or more flux reversal sensing elements 6, and is constituted. In predetermined spacing, it consists and two-dimensional array of each flux reversal sensing element 6 is carried out so that the direction of the coiling heart may become said alternating current field and abbreviation parallel, and it is electrically connected to a substrate 7. Two-dimensional detection data are obtained in an instant, without scanning, when detecting the shape of surface type of analyte 2 using this surface type-like detection sensor 4B. This avoids the detection error resulting from the migration error of analyte 2 or the flux reversal sensing element 6, and it becomes possible to raise detection precision. In addition, since the detection actuation is completed in an instant when detecting the shape of surface type of analyte 2 using the above-mentioned surface type-like detection sensor 4B, analyte 2 and the flux reversal sensing element 6 do not necessarily need to be fixed relatively.

[0011] (A) of drawing 4 is the side elevation of the surface type-like detection sensor in which a flux reversal sensing element unit is shown. The flux reversal sensing element unit 11 shown in this drawing is equipped with the core 12 formed in the shape of continuation, two or more polar zone 13 formed in this core 12 by consisting in predetermined spacing, and two or more coils 14 by which it is wound between these polar zone 13, and those ends are electrically

connected to the polar zone 13, and is constituted. That is, the flux reversal sensing element unit 11 reduces components mark and production processes, and enables a large cost cut while it raises the manufacture effectiveness of the surface type-like detection sensor 4 by constituting in one two or more coils 14 by which one-dimensional array was carried out. In addition, (C) of the top view of the surface type-like detection sensor constituted using a single flux reversal sensing element unit and drawing 4 (B) of drawing 4 Surface type-like detection sensor 4C which is the top view of the surface type-like detection sensor constituted using two or more flux reversal sensing element units, and is shown in (B) of drawing 4 Surface type-like detection sensor 4D which has a function equivalent to said surface type-like detection sensor 4A, and is shown in (C) of drawing 4 has a function equivalent to said surface type-like detection sensor 4B.

[0012] Drawing 5 is the block diagram of actuation and a detecting element. As shown in this drawing, actuation and a detecting element 5 are equipped with the sine wave oscillator 15 which generates an AC signal, and that AC signal branches to the 90-degree phase shifter 16 and power amplification 17. The AC signal inputted into power amplification 17 is amplified, and is impressed to exiting coils 3a and 3b. On the other hand, each flux reversal sensing element 6 is connected to the impedance matching box 18, and the detecting signal by which the impedance was adjusted here is inputted into a multiplexer 19. A channel is chosen one by one by the command of the control logic 20, and a multiplexer 19 outputs a detecting signal to the synchronous-detection circuit 21. The detecting signal inputted into the synchronous-detection circuit 21 makes a reference sign the signal of the 90-degree phase shifter 16, and a synchronous detection is carried out. The output signal of the synchronous-detection circuit 21 is the eddy current loss of the flux reversal by the eddy current, and is a voltage output proportional to the surface inclination of the analyte 2 in the opposite location of the selected flux reversal sensing element 6. After this output signal is inputted into A/D converter 23 through a filter 22 and is digitized here, sequential storing of it is carried out at FIFO memory 24 (First-in First-out Memory). The stored detection data are received and passed to external devices, such as surface type-like visualization equipment, surface-discontinuity test equipment, a coin identification unit, and a surface alphabetic character, an encaustic identification unit. The control logic 20 carries out sequential storing of the detection data at FIFO memory 24, controlling a multiplexer 19 and A/D converter 23, is a sequential circuit which sends this out to an external device, and can also realize a microcomputer.

[0013] Drawing 6 is the block diagram of surface type-like visualization equipment. As shown in this drawing, surface type-like visualization equipment 25 is equipped with the surface type-like detection equipment 1 mentioned above, the signal transformation section 26 which changes into a status signal the detection data outputted from this surface type-like detection equipment 1, and the drop 27 which displays the shape of surface type of analyte 2 according to the status signal outputted from this signal transformation section 26, and is constituted. When the signal transformation section 26 sets M lines, N train, and the display pixel array of an indicator 27 to X and Y for the array of detection data (surface type-like detection sensor 4) and B (m, n) and the pixel brightness of an indicator 27 are set to K (x y) for the value of each detection data, An extension map is interpolated and carried out from B space to K space, and program manipulation using [for example,] the microcomputer besides the wired logic of a simple repetition etc. can also be realized. Moreover, a color interpolation display is also possible if processing same about the brightness of R, G, and B (red, green, blue) is performed, and it becomes possible by changing this into an NTSC signal or an RGB code to display the shape of surface type on a commercial monitor. And since according to the surface type-like visualization equipment 25 of this invention the irregularity which exists in the front face of analyte 2 is emphasized based on the principle expressed previously and it is visible, the deficit blemish in the front face of analyte 2 etc. can be discovered easily, and, moreover, it becomes possible to eliminate the effect by not **** to which exterior lighting becomes unnecessary but disturbance light and dirt compared with the case where optical surface type-like detection equipment is used.

[0014] Drawing 7 is the block diagram of a surface alphabetic character and encaustic recognition equipment. As shown in this drawing, a surface alphabetic character and encaustic recognition equipment 28 are equipped with the surface type-like detection equipment 1 mentioned above and the discernment section 29 which identifies the alphabetic character stamped on the front face of analyte 2 based on the detection data outputted from this surface type-like detection equipment 1, and a pattern, and is constituted. The filter 30 from which the discernment section 29 removes the noise of detection data, and the binary-ized processing section 31 which makes detection data binary using a predetermined threshold, The recognition area specification section 32 which pinpoints recognition area out of binary-ized data, The data correction section 33 which performs revolution actuation of data by a matrix operation etc. when recognition area leans, The matching processing section 34 matched with the reference pattern which divided the above-mentioned recognition area into the fine cel, and was set up beforehand, With the alphabetic character and the encaustic specification section 35 which specifies the alphabetic character stamped on the front face of analyte 2 based

on the hit ratio (correlation frequency), and a pattern, as a result of outputting the result, it has the output section 36, and it is constituted. The program manipulation using a microcomputer besides the hard processing by wired logic etc. can also realize the above-mentioned processing.

[0015] The perspective view of the surface type-like detection equipment with which drawing 8 is prepared in surface-discontinuity test equipment, and drawing 9 are the block diagrams of surface-discontinuity test equipment. As shown in these drawings, surface-discontinuity test equipment 37 is equipped with the surface type-like detection equipment 38 which detects the shape of surface type of analyte 2, and the automatic-check section 39 which checks automatically defects, such as a blemish which exists in the front face of analyte 2 based on the detection data outputted from this surface type-like detection equipment 38, and is constituted. surface type-like detection equipment 38 equips with and constitutes the alternating current field generator 40 equipped with the exiting coils 40a and 40b of a couple, the surface type-like detection sensor 41 equipped with two or more flux reversal sensing elements (not shown) by which one-dimensional array was carried out, and the buttress plate 42 that supports these in one -- having -- **** -- the front face of analyte 2 -- meeting -- hand control -- or it is conveyed automatically. The filter 43 from which the automatic-check section 39 removes the noise of detection data, The binary-ized processing section 44 which makes detection data binary using a predetermined threshold, and the recognition area specification section 45 which pinpoints recognition area out of binary-ized data, The matching processing section 46 matched with the reference pattern which divided the above-mentioned recognition area into the fine cel, and was set up beforehand, With the defective specification section 47 which specifies defects, such as a blemish which exists in the front face of analyte 2 based on the hit ratio (correlation frequency), as a result of outputting the result, it has the output section 48, and it is constituted. The program manipulation using a microcomputer besides the hard processing by wired logic etc. can also realize the above-mentioned processing. Moreover, if said surface type-like visualization equipment 25 is used together, defective inspection can be conducted acting as the monitor of the front face of analyte 2, and it will become possible to raise the precision of defective inspection.

[0016] Drawing in which the perspective view of the surface type-like detection equipment with which drawing 10 is prepared in a coin identification unit, and drawing 11 show the block diagram of a coin identification unit, and drawing 12 shows arrangement of a flux reversal sensing element (cel), and drawing 13 are drawings showing the flux reversal of j lines. As shown in these drawings, the coin identification unit 49 is equipped with the surface type-like detection equipment 51 which detects the shape of surface type of the coin 50 which is analyte (front flesh side), and the coin discernment section 52 which identifies the class and truth of a coin 50 based on the detection data outputted from this surface type-like detection equipment 51, and is constituted. Surface-type-like detection equipment 51 is equipped with two or more flux reversal sensing elements 55 by which two-dimensional array was carried out to the alternating current field generator 54 equipped with the exiting coils 54a and 54b of the couple arranged so that the coin conveyance way 53 may be surrounded, and is equipped with the surface-type-like detection sensor 56 of the couple arranged across the money conveyance way 53 so that each flux-reversal sensing element 55 may meet the generating field of the alternating current field generator 54, and the table rear face of a coin 50, and is constituted. The filter 57 from which the coin discernment section 52 removes the noise of detection data, The outer-diameter extract section 58 which extracts the outer-diameter component D of a coin 50 from detection data, The conductivity and the thickness extract section 59 which extracts the conductivity and thickness component t/rho of a coin 50 (t is thickness and rho is a rate of specific resistance) from detection data, The class judging section 60 which specifies the class Kn of said extracted outer-diameter component D and coin 50 corresponding to conductivity and thickness component t/rho with reference to a class judging table (field which memorizes the outer-diameter component D for every coin, and conductivity and thickness component t/rho), The binary-ized processing section 61 which makes detection data binary using a predetermined threshold, and the matching processing section 62 which divides binary-ized data into a fine cel, and is matched with the reference pattern corresponding to the above-mentioned class Kn, With the truth judging section 63 which judges the truth of a coin 50 based on the hit ratio (correlation frequency), as a result of outputting the result, it has the output section 64, and it is constituted. That is, if the class of coin 50 is set to Kn, the amount of many which specifies Class Kn is the conductivity sigma depending on the outer diameter D of a coin 50, thickness t, weight W, and construction material (sigma=1/rho) etc., among those as an outer diameter D is shown in drawing 13 , the peak of the beginning in detection data (line data passing through a coin core) and the last will be recognized, and it will be computed by counting the number of cels in the meantime. On the other hand, for thickness t and conductivity sigma, the eddy current loss Pe detected by the flux reversal sensing element 55 is Pe=k {(D2tomega2) /rho}. (omega is a frequency)

It comes out and separation is difficult only by the detection data of a certain thing to the flux reversal sensing element 55 (separation is easy if the sensor for conductivity detection is formed separately). Then, in this operation gestalt,

conductivity and thickness component t/rho were extracted from detection data, and the class of coin 50 is judged using this conductivity and thickness component t/rho, and said outer-diameter component D. That is, when the kind Kn of reference pattern and the bit map data which carried out cel decomposition of the detection data are matched when these amounts of many and the amount data of many for every coin set as a class judging table are in agreement in the range of an allowable error, and the hit ratio goes into tolerance, it judges with it being true **, and except [its] is judged to be a counterfeit coin. In addition, as for the above-mentioned reference pattern, the reference pattern for front faces and the reference pattern for rear faces are prepared for every class of coin 50. Moreover, multiple-times activation of the above-mentioned matching processing is carried out rotating the above-mentioned bit map data or a reference pattern in a predetermined pitch, and the truth judging which does not receive effect in the angle of rotation of a coin 50 is performed.

[0017] the case where the shape of surface type of the analyte 2 which consists of a conductor is detected in what was constituted like description -- the front face of said analyte 2 -- abbreviation -- the front face of said analyte 2 the alternating current field generating process of generating an parallel alternating current field, and near -- said field -- abbreviation -- the flux reversal detection process of detecting the flux reversal of the parallel sense is performed. that is, the front face of analyte 2 -- abbreviation -- an eddy current is intensively generated by generating an parallel alternating current field on the side face of the irregularity which exists in the front face of analyte 2 -- making -- the generating situation of this eddy current -- said field -- abbreviation, since it detects as flux reversal of the parallel sense Compared with the former which it became possible to detect clearly the irregularity which exists in the front face of analyte 2, consequently had detected the slight flux reversal based on a concavo-convex height change, detection precision can be raised by leaps and bounds.

[0018] moreover, said analyte 2 -- the front face -- abbreviation -- since the shape of surface type of analyte 2 can be scanned when flux reversal is detected making it move in the parallel direction, things can be carried out and, moreover, the structure of surface type-like detection equipment 1 can be simplified by [which specify the shape of surface type of analyte 2 by few flux reversal sensing elements 6] moving an analyte 2 side at the time of detection.

[0019] the front face of said analyte 2 near [moreover,] -- said field -- abbreviation -- the flux reversal sensing element 6 which detects the flux reversal of the parallel sense the front face of said analyte 2 -- abbreviation, since the shape of surface type of analyte 2 can be scanned also when flux reversal is detected making it move in the parallel direction It becomes possible to also detect the shape of surface type of an anchorage by [which specify the shape of surface type of analyte 2 by few flux reversal sensing elements 6] being able to carry out things and moreover moving the flux reversal sensing element 6 side at the time of detection.

[0020] Moreover, when flux reversal is detected in two or more detection locations by which one-dimensional array was carried out in the direction which carries out an abbreviation rectangular cross to the migration direction of said analyte 2, or the migration direction of the flux reversal sensing element 6, and meets the front face of said analyte 2, two-dimensional detection data can be obtained by the flux reversal sensing element 6 by which one-dimensional array was carried out.

[0021] Moreover, since the shape of surface type of analyte 2 can be detected without scanning when flux reversal is detected in the detection location of a large number by which two-dimensional array was carried out in the direction along the front face of said analyte 2, the detection error resulting from the migration error of analyte 2 or the flux reversal sensing element 6 can be avoided, and detection precision can be raised.

[0022] moreover, the surface type-like detection sensor 4 -- the front face -- abbreviation -- it arranges near [where the parallel alternating current field was generated] the front face of analyte 2 -- having -- said field -- abbreviation -- since it has the flux reversal sensing element 6 which detects the flux reversal of the parallel sense and is constituted, surface type-like detection with a high precision by said approach can be performed.

[0023] since [moreover,] the flux reversal sensing element 6 is arranged to the front face of said analyte 2 in said surface type-like detection sensor 4 at abbreviation parallel -- the front face of analyte 2 -- abbreviation -- the flux reversal of the parallel sense is detectable with a sufficient precision.

[0024] Moreover, in said surface type-like detection sensor 4, when one-dimensional array of the flux reversal sensing element 6 is carried out in the direction along the front face of said analyte 2, two-dimensional detection data can be obtained by moving analyte 2 or the flux reversal sensing element 6 in the abbreviation rectangular cross direction to the array direction of the flux reversal sensing element 6.

[0025] Moreover, in said surface type-like detection sensor 4, since the shape of surface type of analyte 2 can be detected without scanning when two-dimensional array of the flux reversal sensing element 6 is carried out in the direction along the front face of said analyte 2, the detection error resulting from the migration error of analyte 2 or the flux reversal sensing element 6 can be avoided, and detection precision can be raised.

[0026] Moreover, in said surface type-like detection sensor 4, when the flux reversal sensing element 6 is used as a coil, a chip inductor, a hall device, or a magnetic resistance element, the surface type-like detection sensor 4 can be constituted using the existing magnetic device.
[0027] Moreover, in said surface type-like detection sensor 4, when the flux reversal sensing element unit 11 is constituted using the core 12 formed in the shape of continuation, and two or more coils 14 wound around this core 12 by consisting in predetermined spacing, not **** that can manufacture efficiently two or more magnetic variation sensing elements by which one-dimensional array was carried out but components mark and production processes can be reduced, and a large cost cut can be aimed at.
[0028] moreover, surface type-like detection equipment 1 -- the front face of said analyte 2 -- abbreviation -- the front face of said analyte 2 the alternating current field generator 3 made to generate an parallel alternating current field and near -- said field -- abbreviation -- since it has the surface type-like detection sensor 4 which detects the flux reversal of the parallel sense and is constituted, surface type-like detection with a high precision using said approach can be performed.
[0029] Moreover, since the coin identification unit 49 matches the detected surface type-like data with the reference pattern set up beforehand and identifies said coin 50 based on the hit ratio after it detects the shape of surface type of a coin 50 using said surface type-like detection approach (surface type-like detection equipment), it can identify a coin 50 with a sufficient precision based on surface type-like data with a high precision.
[0030] Moreover, since surface-discontinuity test equipment 37 matches the detected surface type-like data with the reference pattern set up beforehand and judges the surface discontinuity of said analyte 2 based on the hit ratio after it detects the shape of surface type of analyte 2 using said surface type-like detection approach (surface type-like detection equipment), it can judge the surface discontinuity of analyte 2 with a sufficient precision based on surface type-like data with a high precision.
[0031] Moreover, since surface type-like visualization equipment 25 is equipped with the signal transformation section 26 which changes into the status signal of a drop 27 the surface type-like data of the analyte 2 detected using said surface type-like detection approach (surface type-like detection equipment), it can display the shape of surface type of analyte 2 with a sufficient precision based on surface type-like detection data with a high precision.

[Translation done.]

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CLAIMS

[Claim(s)]
[Claim 1] the approach of detecting the shape of surface type of the analyte which consists of a conductor -- it is -- the front face of said analyte -- abbreviation -- the front face of said analyte the alternating current field generating process of generating an parallel alternating current field, and near -- said field -- abbreviation -- the surface type-like detection approach characterized by having the flux reversal detection process of detecting the flux reversal of the parallel sense.
[Claim 2] said flux reversal detection process -- said analyte -- the front face -- abbreviation -- the surface type-like detection approach according to claim 1 characterized by performing making it move in the parallel direction.
[Claim 3] said flux reversal detection process -- the near front face of said analyte -- said field -- abbreviation -- the flux reversal sensing element which detects the flux reversal of the parallel sense -- the front face of said analyte -- abbreviation -- the surface type-like detection approach according to claim 1 characterized by performing making it move in the parallel direction.
[Claim 4] Said flux reversal detection process is the surface type-like detection approach according to claim 2 or 3 characterized by performing in two or more detection locations by which one-dimensional array was carried out in the direction which carries out an abbreviation rectangular cross to the migration direction of said analyte, or the migration direction of a flux reversal sensing element, and meets the front face of said analyte.
[Claim 5] Said flux reversal detection process is the surface type-like detection approach according to claim 1 characterized by performing in the detection location of a large number by which two-dimensional array was carried out in the direction along the front face of said analyte.
[Claim 6] the sensor which detects the shape of surface type of the analyte which consists of a conductor -- it is -- the front face -- abbreviation -- it arranges near [where the parallel alternating current field was generated] the front face of analyte -- having -- said field -- abbreviation -- the surface type-like detection sensor characterized by having the flux reversal sensing element which detects the flux reversal of the parallel sense.
[Claim 7] Said flux reversal sensing element is a surface type-like detection sensor according to claim 6 characterized by being arranged to the front face of said analyte at abbreviation parallel.
[Claim 8] Said flux reversal sensing element is a surface type-like detection sensor according to claim 6 or 7 characterized by carrying out one-dimensional array in the direction along the front face of said analyte.
[Claim 9] Said flux reversal sensing element is a surface type-like detection sensor according to claim 6 or 7 characterized by carrying out two-dimensional array in the direction along the front face of said analyte.
[Claim 10] Said flux reversal sensing element is a surface type-like detection sensor according to claim 6 to 9 characterized by being a coil, a chip inductor, a hall device, or a magnetic resistance element.
[Claim 11] Said flux reversal sensing element is a surface type-like detection sensor according to claim 6 to 10 characterized by having the core formed in the shape of continuation, and two or more coils wound around this core by consisting in predetermined spacing, and being constituted.
[Claim 12] the equipment which detects the shape of surface type of the analyte which consists of a conductor -- it is -- the front face of said analyte -- abbreviation -- the front face of said analyte an alternating current field generating means to generate an parallel alternating current field, and near -- said field -- abbreviation -- the surface type-like detection equipment characterized by having a flux reversal detection means to detect the flux reversal of the parallel sense.
[Claim 13] Said flux reversal detection means is surface type-like detection equipment according to claim 12 characterized by being the flux reversal sensing element arranged to the front face of said analyte at abbreviation parallel.
[Claim 14] Said flux reversal detection means is surface type-like detection equipment according to claim 12 or 13 characterized by being two or more flux reversal sensing elements by which one-dimensional array was carried out in

the direction along the front face of said analyte.

[Claim 15] Said flux reversal detection means is surface type-like detection equipment according to claim 12 or 13 characterized by being the flux reversal sensing element of a large number by which two-dimensional array was carried out in the direction along the front face of said analyte.

[Claim 16] Said flux reversal detection means is surface type-like detection equipment according to claim 12 to 15 characterized by being a coil, a chip inductor, a hall device, or a magnetic resistance element.

[Claim 17] Said flux reversal detection means is surface type-like detection equipment according to claim 12 to 16 characterized by having the core formed in the shape of continuation, and two or more coils wound around this core by consisting in predetermined spacing, and being constituted.

[Claim 18] The coin discernment approach characterized by to have the surface-type-like detection process of being the coin discernment approach using the surface-type-like detection approach given in any of claims 1-5 they being, and detecting the shape of surface type of a coin using said surface-type-like detection approach, and the coin discernment judging process of matching the detected surface-type-like data with the reference pattern set up beforehand, and identifying said coin based on the hit ratio.

[Claim 19] The coin identification unit characterized by having a coin discernment means to be the coin identification unit equipped with surface type-like detection equipment given in any of claims 12-17 they are, to match the surface type-like data of the coin detected using said surface type-like detection equipment with the reference pattern set up beforehand, and to identify said coin based on the hit ratio.

[Claim 20] The surface-discontinuity inspection approach characterized by to have the surface-type-like detection process of being the surface-discontinuity inspection approach using the surface-type-like detection approach given in any of claims 1-5 they being, and detecting the shape of surface type of analyte using said surface-type-like detection approach, and the surface-discontinuity judging process of matching the detected surface-type-like data with the reference pattern set up beforehand, and judging the surface discontinuity of said analyte based on the hit ratio.

[Claim 21] Surface-discontinuity test equipment characterized by having a surface-discontinuity judging means to be surface-discontinuity test equipment equipped with surface type-like detection equipment given in any of claims 12-17 they are, to match the surface type-like data of the analyte detected using said surface type-like detection equipment with the reference pattern set up beforehand, and to judge the surface discontinuity of said analyte based on the hit ratio.

[Claim 22] Surface type-like visualization equipment characterized by having a signal transformation means to be surface type-like visualization equipment equipped with surface type-like detection equipment given in any of claims 12-17 they are, and to change into the status signal of a display the surface type-like data of the analyte detected using said surface type-like detection equipment.

[Translation done.]

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the outline sectional view of surface type-like detection equipment.
[Drawing 2] It is the side elevation of the flux reversal sensing element which consisted of air cored coils.
[Drawing 3] For (A), the top view of the surface type-like detection sensor by which one-dimensional array of the flux reversal sensing element was carried out, and (B) are the top views of the surface type-like detection sensor by which two-dimensional array of the flux reversal sensing element was carried out.
[Drawing 4] The side elevation of the surface type-like detection sensor which (A) shows a flux reversal sensing element unit, the top view of the surface type-like detection sensor by which (B) is constituted using a single flux reversal sensing element unit, and (C) are the top views of the surface type-like detection sensor constituted using two or more flux reversal sensing element units.
[Drawing 5] It is the block diagram of actuation and a detecting element.
[Drawing 6] It is the block diagram of surface type-like visualization equipment.
[Drawing 7] It is the block diagram of a surface alphabetic character and encaustic recognition equipment.
[Drawing 8] It is the perspective view of the surface type-like detection equipment formed in surface-discontinuity test equipment.
[Drawing 9] It is the block diagram of surface-discontinuity test equipment.
[Drawing 10] It is the perspective view of the surface type-like detection equipment formed in a coin identification unit.
[Drawing 11] It is the block diagram of a coin identification unit.
[Drawing 12] It is drawing showing arrangement of a flux reversal sensing element (cel).
[Drawing 13] It is drawing showing the flux reversal of j lines.
[Description of Notations]
1 Surface Type-like Detection Equipment
2 Analyte
3 Alternating Current Field Generator
3a Exiting coil
3b Exiting coil
4 Surface Type-like Detection Sensor
5 Actuation and Detecting Element
6 Flux Reversal Sensing Element
7 Substrate
8 Core
9 Polar Zone
10 Coil
11 Flux Reversal Sensing Element Unit
12 Core
13 Polar Zone
14 Coil
25 Surface Type-like Visualization Equipment
28 Surface Alphabetic Character and Encaustic Recognition Equipment
37 Surface-Discontinuity Test Equipment
38 Surface Type-like Detection Equipment

40 Alternating Current Field Generator
41 Surface Type-like Detection Sensor
49 Coin Identification Unit
50 Coin
51 Surface Type-like Detection Equipment
52 Coin Discernment Section
53 Coin Conveyance Way
54 Alternating Current Field Generator
55 Flux Reversal Sensing Element
56 Surface Type-like Detection Sensor

[Translation done.]

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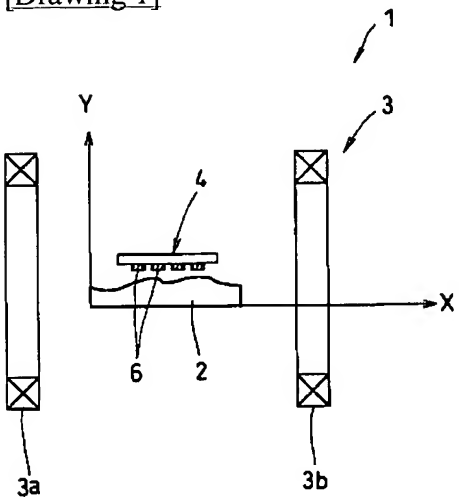
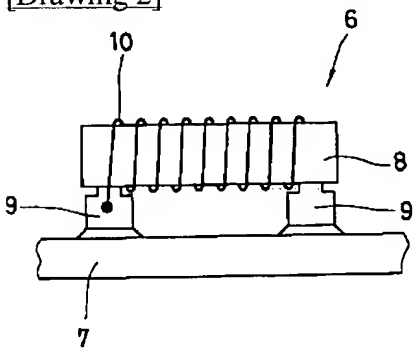
DRAWINGS

[Drawing 1]

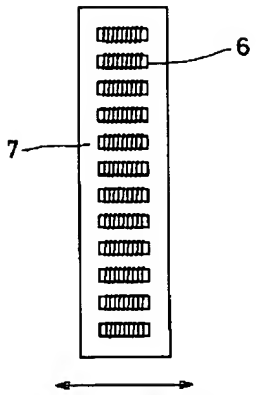


[Drawing 2]



[Drawing 3]

(A)



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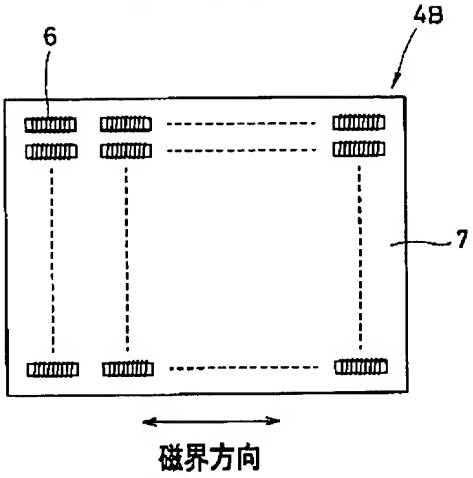

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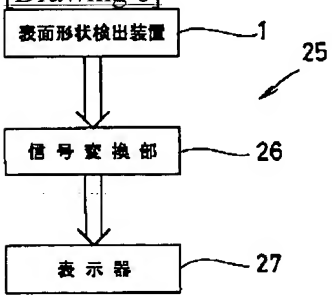

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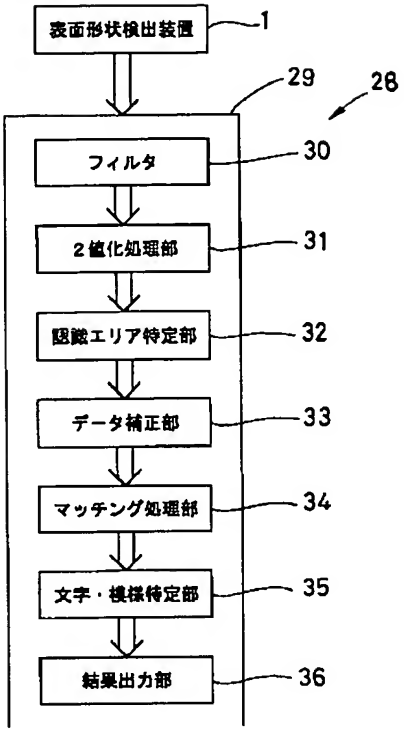
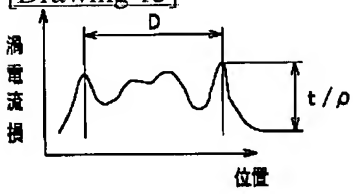
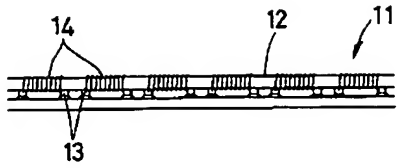


[Drawing 13]



[Drawing 4]

(A)



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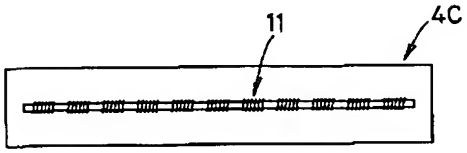
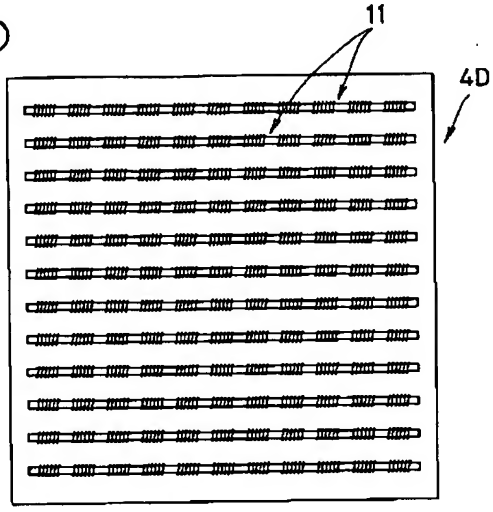
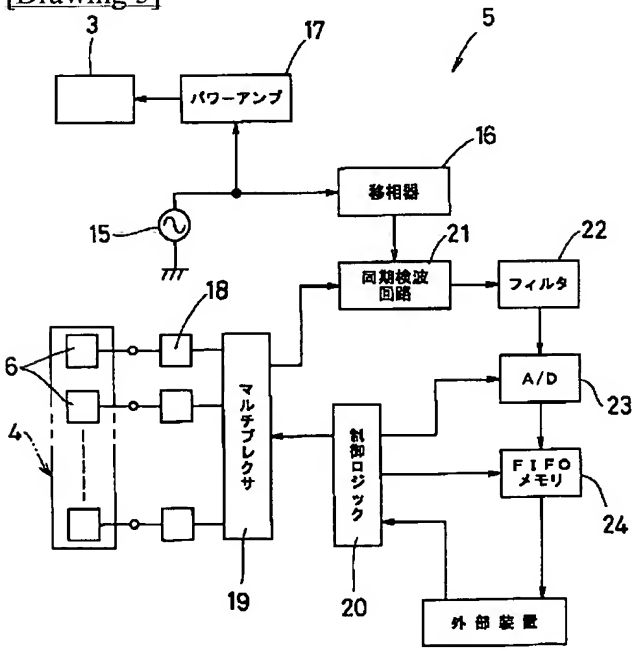


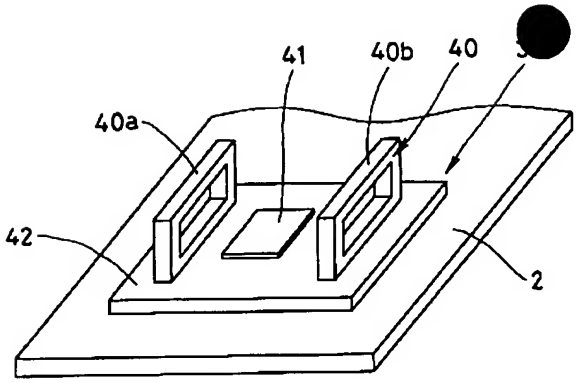
(C)



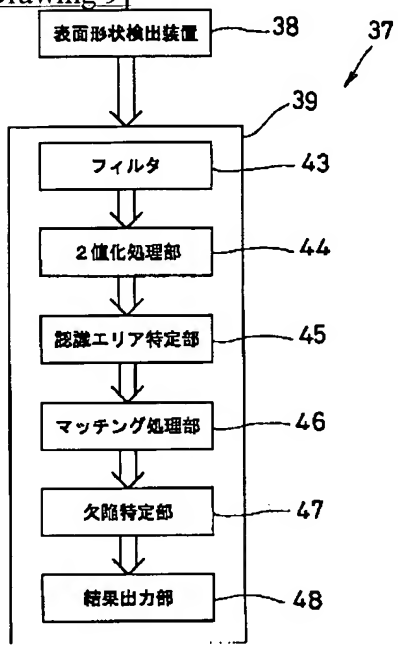
[Drawing 5]



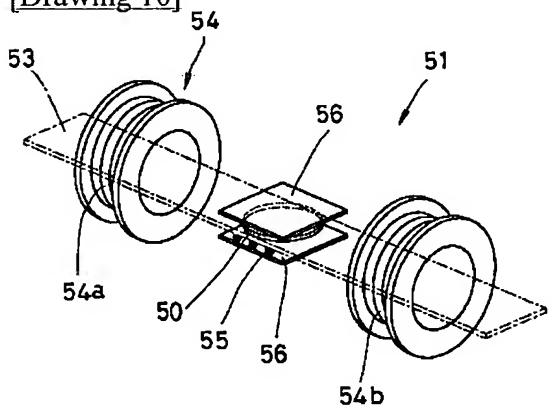
[Drawing 8]



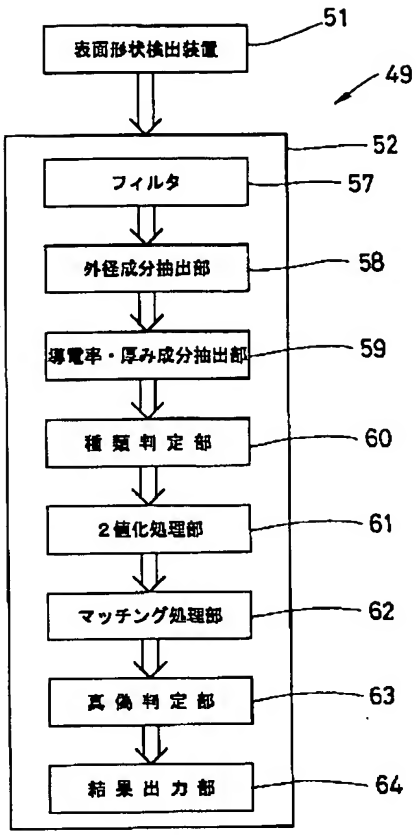
[Drawing 9]



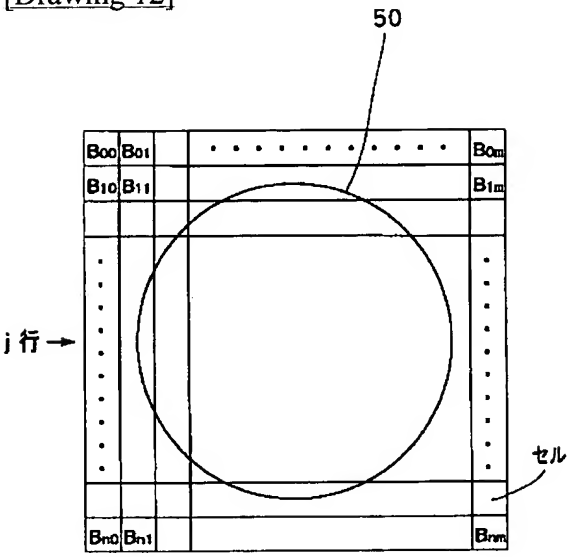
[Drawing 10]



[Drawing 11]



[Drawing 12]



[Translation done.]

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Ｇ０７Ｄ　5/02	１０４	Ｇ０７Ｄ　5/02	１０４	３Ｅ００２
5/08		5/08		
	１０３		１０３	

審査請求　未請求　請求項の数22　ＯＬ　（全 11 頁）

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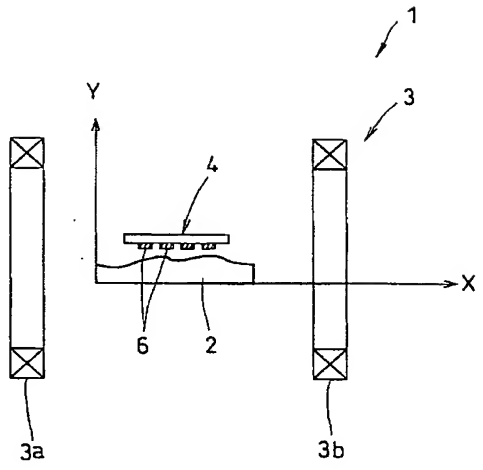
最終頁に続く

(54)【発明の名称】　表面形状検出方法、表面形状検出センサ、表面形状検出装置、硬貨識別方法、硬貨識別装置、表面欠陥検査方法、表面欠陥検査装置および表面形状可視化装置

(57)【要約】
【課題】　導体からなる被検体の表面形状を精度良く検出する。
【解決手段】　方法としては、被検体２の表面に略平行な交流磁界を発生させる交流磁界発生工程と、前記被検体２の表面近傍で前記磁界に略平行な向きの磁束変化を検出する磁束変化検出工程とを備え、装置としては、被検体２の表面に略平行な交流磁界を発生させる交流磁界発生装置３と、前記被検体２の表面近傍で前記磁界に略平行な向きの磁束変化を検出する表面形状検出センサ４とを備える。



【特許請求の範囲】

【請求項１】　導体からなる被検体の表面形状を検出する方法であって、
前記被検体の表面に略平行な交流磁界を発生させる交流磁界発生工程と、
前記被検体の表面近傍で前記磁界に略平行な向きの磁束変化を検出する磁束変化検出工程とを備えることを特徴とする表面形状検出方法。

【請求項２】　前記磁束変化検出工程は、前記被検体を、その表面に略平行な方向に移動させながら実行されることを特徴とする請求項１に記載の表面形状検出方法。

【請求項３】　前記磁束変化検出工程は、前記被検体の表面近傍で前記磁界に略平行な向きの磁束変化を検出する磁束変化検出素子を、前記被検体の表面に略平行な方向に移動させながら実行されることを特徴とする請求項１に記載の表面形状検出方法。

【請求項４】　前記磁束変化検出工程は、前記被検体の移動方向、もしくは磁束変化検出素子の移動方向に対して略直交し、かつ、前記被検体の表面に沿う方向に１次元配列された複数の検出位置で実行されることを特徴とする請求項２又は３に記載の表面形状検出方法。

【請求項５】　前記磁束変化検出工程は、前記被検体の表面に沿う方向に２次元配列された多数の検出位置で実行されることを特徴とする請求項１に記載の表面形状検出方法。

【請求項６】　導体からなる被検体の表面形状を検出するセンサであって、その表面に略平行な交流磁界が発生された被検体の表面近傍に配置され、前記磁界に略平行な向きの磁束変化を検出する磁束変化検出素子を備えることを特徴とする表面形状検出センサ。

【請求項７】　前記磁束変化検出素子は、前記被検体の表面に対して略平行に配置されることを特徴とする請求項６に記載の表面形状検出センサ。

【請求項８】　前記磁束変化検出素子は、前記被検体の表面に沿う方向に１次元配列されることを特徴とする請求項６又は７に記載の表面形状検出センサ。

【請求項９】　前記磁束変化検出素子は、前記被検体の表面に沿う方向に２次元配列されることを特徴とする請求項６又は７に記載の表面形状検出センサ。

【請求項１０】　前記磁束変化検出素子は、コイル、チップインダクタ、ホール素子もしくは磁気抵抗素子であることを特徴とする請求項６～９に記載の表面形状検出センサ。

【請求項１１】　前記磁束変化検出素子は、連続状に形成されたコアと、該コアに所定間隔を存して巻回される複数のコイルとを備えて構成されることを特徴とする請求項６～１０に記載の表面形状検出センサ。

【請求項１２】　導体からなる被検体の表面形状を検出する装置であって、
前記被検体の表面に略平行な交流磁界を発生させる交流磁界発生手段と、
前記被検体の表面近傍で前記磁界に略平行な向きの磁束変化を検出する磁束変化検出手段とを備えることを特徴とする表面形状検出装置。

【請求項１３】　前記磁束変化検出手段は、前記被検体の表面に対して略平行に配置された磁束変化検出素子であることを特徴とする請求項１２に記載の表面形状検出装置。

【請求項１４】　前記磁束変化検出手段は、前記被検体の表面に沿う方向に１次元配列された複数の磁束変化検出素子であることを特徴とする請求項１２又は１３に記載の表面形状検出装置。

【請求項１５】　前記磁束変化検出手段は、前記被検体の表面に沿う方向に２次元配列された多数の磁束変化検出素子であることを特徴とする請求項１２又は１３に記載の表面形状検出装置。

【請求項１６】　前記磁束変化検出手段は、コイル、チップインダクタ、ホール素子もしくは磁気抵抗素子であることを特徴とする請求項１２～１５に記載の表面形状検出装置。

【請求項１７】　前記磁束変化検出手段は、連続状に形成されたコアと、該コアに所定間隔を存して巻回される複数のコイルとを備えて構成されることを特徴とする請求項１２～１６に記載の表面形状検出装置。

【請求項１８】　請求項１～５の何れかに記載の表面形状検出方法を用いた硬貨識別方法であって、
前記表面形状検出方法を用いて硬貨の表面形状を検出する表面形状検出工程と、
検出した表面形状データを、予め設定された参照パターンとマッチングし、そのヒット率に基づいて前記硬貨を識別する硬貨識別判定工程とを備えることを特徴とする硬貨識別方法。

【請求項１９】　請求項１２～１７の何れかに記載の表面形状検出装置を備えた硬貨識別装置であって、
前記表面形状検出装置を用いて検出した硬貨の表面形状データを、予め設定された参照パターンとマッチングし、そのヒット率に基づいて前記硬貨を識別する硬貨識別手段を備えることを特徴とする硬貨識別装置。

【請求項２０】　請求項１～５の何れかに記載の表面形状検出方法を用いた表面欠陥検査方法であって、
前記表面形状検出方法を用いて被検体の表面形状を検出する表面形状検出工程と、
検出した表面形状データを、予め設定された参照パターンとマッチングし、そのヒット率に基づいて前記被検体の表面欠陥を判定する表面欠陥判定工程とを備えることを特徴とする表面欠陥検査方法。

【請求項２１】　請求項１２～１７の何れかに記載の表面形状検出装置を備えた表面欠陥検査装置であって、
前記表面形状検出装置を用いて検出した被検体の表面形

状データを、予め設定された参照パターンとマッチングし、そのヒット率に基づいて前記被検体の表面欠陥を判定する表面欠陥判定手段を備えることを特徴とする表面欠陥検査装置。

【請求項２２】　請求項１２～１７の何れかに記載の表面形状検出装置を備えた表面形状可視化装置であって、前記表面形状検出装置を用いて検出した被検体の表面形状データを、表示装置の表示信号に変換する信号変換手段を備えることを特徴とする表面形状可視化装置。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、導体の表面形状を検出する表面形状検出方法、表面形状検出センサおよび表面形状検出装置に関し、さらには、前記表面形状検出方法を用いた硬貨識別方法、前記表面形状検出装置を備えた硬貨識別装置、前記表面形状検出方法を用いた表面欠陥検査方法、前記表面形状検出装置を備えた表面欠陥検査装置および表面形状可視化装置に関する。

【０００２】

【従来の技術】近年、導体からなる被検体の表面形状を非接触で検出する方法（装置）が種々開発されている。これらの検出方法は、例えば硬貨識別装置、表面欠陥検査装置、表面形状可視化装置等の分野で利用されており、その検出精度を高めることが強く要望されている。上記検出方法としては、光学的な手段を用いるものと、磁気的な手段を用いるものとに大別される。光学的な検出方法としては、ＣＣＤセンサを用いて被検体表面を撮影し、その撮影データを画像処理して表面形状を特定するものや、被検体表面の反射光をホトダイオード等の受光デバイスで受光し、その受光レベルに基づいて表面形状を特定するものが知られているが、光学的な検出方法にあっては、被検体表面の汚れに影響を受け易い許りでなく、凹凸の高さや深さを検出できないため、汚れを含む二次元的な検出データしか得られず、その用途が限定される不都合がある。一方、磁気的な検出方法としては、交流磁界中における導体の渦電流効果を利用するものが知られている。渦電流は、交流磁場に金属などの導体が置かれたとき、導体を貫く磁束の変化を妨げるように導体内部に発生するもので、その発生具合が導体の表面形状に応じて変化することから、渦電流による磁束変化を導体の表面近傍で検出することにより、導体の表面形状を検出することが可能になる。

【０００３】

【発明が解決しようとする課題】しかしながら、上記従来のものでは、被検体の表面近傍に、そのコイル巻き芯方向が被検体表面に対して垂直方向を向くように励磁コイルおよび検出コイルを配置し、該励磁コイルによって被検体表面に対して垂直な交流磁界を発生させつつ、その近傍における磁束変化を上記検出コイルで検出するため、被検体表面における凹凸の高さ変化（深さ変化）に起因する僅かな磁束変化に基づいて表面形状を特定する必要があり、その検出精度に限界があった。

【０００４】

【課題を解決するための手段】上記の如き実情に鑑みこれらの課題を解決することを目的として創作された本発明は、導体からなる被検体の表面形状を検出する方法であって、前記被検体の表面に略平行な交流磁界を発生させる交流磁界発生工程と、前記被検体の表面近傍で前記磁界に略平行な向きの磁束変化を検出する磁束変化検出工程とを備えることを特徴とする。つまり、被検体の表面に略平行な交流磁界を発生させることにより、被検体の表面に存在する凹凸の側面に渦電流を集中的に発生させ、該渦電流の発生状況を、前記磁界に略平行な向きの磁束変化として検出するため、被検体表面の凹凸を明確に検出することが可能になり、その結果、凹凸の高さ変化に基づく僅かな磁束変化を検出していた従来に比べ、検出精度を飛躍的に向上させることができる。また、前記磁束変化検出工程は、前記被検体を、その表面に略平行な方向に移動させながら実行されることを特徴とする。この場合においては、被検体の表面形状をスキャニングするため、少ない磁束変化検出素子で被検体の表面形状を特定することでき、しかも、検出時に被検体側を移動させることにより、表面形状検出装置の構造を簡略化することができる。また、前記磁束変化検出工程は、前記被検体の表面近傍で前記磁界に略平行な向きの磁束変化を検出する磁束変化検出素子を、前記被検体の表面に略平行な方向に移動させながら実行されることを特徴とする。この場合においては、被検体の表面形状をスキャニングするため、少ない磁束変化検出素子で被検体の表面形状を特定することでき、しかも、検出時に磁束変化検出素子側を移動させるため、固定物の表面形状も検出することができる。また、前記磁束変化検出工程は、前記被検体の移動方向、もしくは磁束変化検出素子の移動方向に対して略直交し、かつ、前記被検体の表面に沿う方向に１次元配列された複数の検出位置で実行されることを特徴とする。この場合においては、１次元配列された磁束変化検出素子によって、２次元の検出データを得ることができる。また、前記磁束変化検出工程は、前記被検体の表面に沿う方向に２次元配列された多数の検出位置で実行されることを特徴とする。この場合においては、被検体の表面形状を、スキャニングすることなく検出できるため、被検体もしくは磁束変化検出素子の移動誤差に起因する検出誤差を回避し、検出精度を向上させることができる。また、上記の如き実情に鑑みこれらの課題を解決することを目的として創作された本発明は、導体からなる被検体の表面形状を検出するセンサであって、その表面に略平行な交流磁界が発生された被検体の表面近傍に配置され、前記磁界に略平行な向きの磁束変化を検出する磁束変化検出素子を備えることを特徴とする。つまり、表面に略平行な交流磁界が発生された

被検体においては、その表面に存在する凹凸の側面に渦電流が集中的に発生し、該渦電流の発生状況を、前記磁界に略平行な向きの磁束変化として検出するため、被検体表面の凹凸を明確に検出することができ、その結果、凹凸の高さ変化に基づく僅かな磁束変化を検出する従来の表面形状検出センサに比べ、検出精度を飛躍的に向上させることができる。また、前記磁束変化検出素子は、前記被検体の表面に対して略平行に配置されることを特徴とする。この場合においては、被検体の表面に略平行な向きの磁束変化を、被検体の表面に対して略平行に配置され磁束変化検出素子で検出することにより、磁束変化の検出精度を高めることができる。また、前記磁束変化検出素子は、前記被検体の表面に沿う方向に１次元配列されることを特徴とする。この場合においては、被検体もしくは磁束変化検出素子を、磁束変化検出素子の配列方向に対して略直交方向に移動させることにより、２次元の検出データを得ることができる。また、前記磁束変化検出素子は、前記被検体の表面に沿う方向に２次元配列されることを特徴とする。この場合においては、被検体の表面形状を、スキャニングすることなく検出できるため、被検体もしくは磁束変化検出素子の移動誤差に起因する検出誤差を回避し、検出精度を向上させることができる。また、前記磁束変化検出素子は、コイル、チップインダクタ、ホール素子もしくは磁気抵抗素子であることを特徴とする。この場合においては、既存の磁気デバイスを利用して表面形状検出センサを構成することができる。また、前記磁束変化検出素子は、連続状に形成されたコアと、該コアに所定間隔を存して巻回される複数のコイルとを備えて構成されることを特徴とする。この場合においては、１次元配列された複数の磁気変化検出素子を、効率よく製造できる許りでなく、部品点数や製造工程を削減して大幅なコストダウンを図ることができる。また、上記の如き実情に鑑みこれらの課題を解決することを目的として創作された本発明は、導体からなる被検体の表面形状を検出する装置であって、前記被検体の表面に略平行な交流磁界を発生させる交流磁界発生手段と、前記被検体の表面近傍で前記磁界に略平行な向きの磁束変化を検出する磁束変化検出手段とを備えることを特徴とする。つまり、被検体の表面に略平行な交流磁界を発生させることにより、被検体の表面に存在する凹凸の側面に渦電流を集中的に発生させ、該渦電流の発生状況を、前記磁界に略平行な向きの磁束変化として検出するため、被検体表面の凹凸を明確に検出することが可能になり、その結果、凹凸の高さ変化に基づく僅かな磁束変化を検出していた従来に比べ、検出精度を飛躍的に向上させることができる。また、前記磁束変化検出手段は、前記被検体の表面に対して略平行に配置された磁束変化検出素子であることを特徴とする。この場合においては、被検体の表面に略平行な向きの磁束変化を、被検体の表面に対して略平行に配置され磁束変化検出素子で検出することにより、磁束変化の検出精度を高めることができる。また、前記磁束変化検出手段は、前記被検体の表面に沿う方向に１次元配列された複数の磁束変化検出素子であることを特徴とする。この場合においては、被検体もしくは磁束変化検出素子を、磁束変化検出素子の配列方向に対して略直交方向に移動させることにより、２次元の検出データを得ることができる。また、前記磁束変化検出手段は、前記被検体の表面に沿う方向に２次元配列された多数の磁束変化検出素子であることを特徴とする。この場合においては、被検体の表面形状を、スキャニングすることなく検出できるため、被検体もしくは磁束変化検出素子の移動誤差に起因する検出誤差を回避し、検出精度を向上させることができる。また、前記磁束変化検出手段は、コイル、チップインダクタ、ホール素子もしくは磁気抵抗素子であることを特徴とする。この場合においては、既存の磁気デバイスを利用して表面形状検出センサを構成することができる。また、前記磁束変化検出手段は、連続状に形成されたコアと、該コアに所定間隔を存して巻回される複数のコイルとを備えて構成されることを特徴とする。この場合においては、１次元配列された複数の磁気変化検出素子を、効率よく製造できる許りでなく、部品点数や製造工程を削減して大幅なコストダウンを図ることができる。また、上記の如き実情に鑑みこれらの課題を解決することを目的として創作された本発明は、請求項１～５の何れかに記載の表面形状検出方法を用いた硬貨識別方法であって、前記表面形状検出方法を用いて硬貨の表面形状を検出する表面形状検出工程と、検出した表面形状データを、予め設定された参照パターンとマッチングし、そのヒット率に基づいて前記硬貨を識別する硬貨識別判定工程とを備えることを特徴とする。つまり、前記表面形状検出方法を用いて検出した精度の高い表面形状データに基づいて硬貨を識別するため、硬貨の識別精度を向上させることができる。また、上記の如き実情に鑑みこれらの課題を解決することを目的として創作された本発明は、請求項１２～１７の何れかに記載の表面形状検出装置を備えた硬貨識別装置であって、前記表面形状検出装置を用いて検出した硬貨の表面形状データを、予め設定された参照パターンとマッチングし、そのヒット率に基づいて前記硬貨を識別する硬貨識別手段を備えることを特徴とする。つまり、前記表面形状検出装置を用いて検出した精度の高い表面形状データに基づいて硬貨を識別するため、硬貨の識別精度を向上させることができる。また、上記の如き実情に鑑みこれらの課題を解決することを目的として創作された本発明は、請求項１～５の何れかに記載の表面形状検出方法を用いた表面欠陥検査方法であって、前記表面形状検出方法を用いて被検体の表面形状を検出する表面形状検出工程と、検出した表面形状データを、予め設定された参照パターンとマッチングし、そのヒット率に基づいて前記被検体の表面欠陥を判

定する表面欠陥判定工程とを備えることを特徴とする。つまり、前記表面形状検出方法を用いて検出した精度の高い表面形状データに基づいて被検体の表面欠陥を判定するするため、表面欠陥の判定精度を向上させることができる。また、請求項１２～１７の何れかに記載の表面形状検出装置を備えた表面欠陥検査装置であって、前記表面形状検出装置を用いて検出した被検体の表面形状データを、予め設定された参照パターンとマッチングし、そのヒット率に基づいて前記被検体の表面欠陥を判定する表面欠陥判定手段を備えることを特徴とする。つまり、前記表面形状検出装置を用いて検出した精度の高い表面形状データに基づいて被検体の表面欠陥を判定するするため、表面欠陥の判定精度を向上させることができる。また、上記の如き実情に鑑みこれらの課題を解決することを目的として創作された本発明は、請求項１２～１７の何れかに記載の表面形状検出装置を備えた表面形状可視化装置であって、前記表面形状検出装置を用いて検出した被検体の表面形状データを、表示装置の表示信号に変換する信号変換手段を備えることを特徴とする。つまり、前記表面形状検出装置を用いて検出した精度の高い表面形状データに基づいて被検体の表面形状を表示するため、被検体の表面形状を精度良く表示することができる。

【０００５】

【発明の実施の形態】次に、本発明の実施の形態の一つを図面に基づいて説明する。図面において、１は導体からなる被検体２の表面形状を検出する表面形状検出装置であって、該表面形状検出装置１は、被検体２の表面に略平行な交流磁界を発生させる交流磁界発生装置（交流磁界発生手段）３と、被検体２の表面近傍で前記磁界に略平行な向きの磁束変化を検出する表面形状検出センサ（磁束変化検出手段）４と、交流磁界発生装置３の駆動回路および表面形状検出センサ４の検出回路を含む駆動・検出部５とを備えて構成される。

【０００６】交流磁界発生装置３は、所定間隔を存して配置される一対の励磁コイル３ａ、３ｂを備える。一対の励磁コイル３ａ、３ｂは、交流信号により励磁駆動され、両コイル３ａ、３ｂ間に交流磁界を発生させる。被検体２は、その表面が前記磁界と略平行になるように両コイル３ａ、３ｂ間に置かれる。被検体２の表面に略平行に発生された交流磁界は、被検体２の表面に存在する凹凸の側面（傾斜面を含む）に渦電流を集中的に発生させ、この渦電流による磁束変化が表面形状検出センサ４によって検出される。

【０００７】表面形状検出センサ４は、磁束変化を検出する磁束変化検出素子６と、該磁束変化検出素子６を支持する基板７とを備えて構成される。磁束変化検出素子６としては、本実施形態で採用する空心コイルの他、フェライトコアやアモルファスコアに巻回されたコイル、巻線式のチップインダクタ、ホール素子、磁気抵抗素子等を用いることができる。

【０００８】図２は、空心コイルで構成された磁束変化検出素子の側面図である。この図に示すように、空心コイルを用いて構成される磁束変化検出素子６は、例えば溶融石英で形成されるコア８と、該コア８の両端凸部にメッキ等を施して形成される電極部９と、上記コア８に巻回され、その両端が電極部９に電気的に接続されるコイル１０とを備えて構成されており、単体素子もしくは複数の素子群としてし使用される。磁束変化検出素子６は、そのコイル巻き芯方向が前記交流磁界と略平行で、かつ、前記被検体２の表面と略平行になるように被検体２の表面近傍に配置され、前記交流磁界に略平行な向きの磁束変化を検出する。

【０００９】図３の（Ａ）は、磁束変化検出素子が１次元配列された表面形状検出センサの平面図である。この図に示す表面形状検出センサ４Ａは、複数の磁束変化検出素子６を１次元配列して構成される。各磁束変化検出素子６は、そのコイル巻き芯方向が前記交流磁界と略平行になるように所定間隔を存して１次元配列され、基板７に電気的に接続される。この表面形状検出センサ４Ａを用いて被検体２の表面形状を検出する場合は、被検体２もしくは表面形状検出センサ４Ａを、磁束変化検出素子６の配列方向に略直交する方向に移動させながら実行される。これにより、被検体２の表面形状がスキャニングされ、１次元配列された磁束変化検出素子６によって２次元の検出データを得ることが可能になる。

【００１０】図３の（Ｂ）は、磁束変化検出素子が２次元配列された表面形状検出センサの平面図である。この図に示す表面形状検出センサ４Ｂは、複数の磁束変化検出素子６を２次元配列して構成される。各磁束変化検出素子６は、そのコイル巻き芯方向が前記交流磁界と略平行になるように所定間隔を存して２次元配列され、基板７に電気的に接続される。この表面形状検出センサ４Ｂを用いて被検体２の表面形状を検出する場合は、スキャニングを行うことなく、瞬時に２次元の検出データが得られる。これにより、被検体２もしくは磁束変化検出素子６の移動誤差に起因する検出誤差を回避し、検出精度を向上させることが可能になる。尚、上記表面形状検出センサ４Ｂを用いて被検体２の表面形状を検出する場合は、その検出動作が瞬時に完了するため、被検体２と磁束変化検出素子６とが必ずしも相対的に固定されている必要はない。

【００１１】図４の（Ａ）は、磁束変化検出素子ユニットを示す表面形状検出センサの側面図である。この図に示す磁束変化検出素子ユニット１１は、連続状に形成されたコア１２と、該コア１２に所定間隔を存して形成される複数の電極部１３と、該電極部１３間に巻回され、その両端が電極部１３に電気的に接続される複数のコイル１４とを備えて構成される。つまり、磁束変化検出素子ユニット１１は、１次元配列された複数のコイル１４

を一体的に構成することにより、表面形状検出センサ４の製造効率を向上させると共に、部品点数や製造工程を削減して大幅なコストダウンを可能にする。尚、図４の（Ｂ）は、単一の磁束変化検出素子ユニットを用いて構成される表面形状検出センサの平面図、図４の（Ｃ）は、複数の磁束変化検出素子ユニットを用いて構成される表面形状検出センサの平面図であり、図４の（Ｂ）に示す表面形状検出センサ４Ｃは、前記表面形状検出センサ４Ａと同等の機能を有し、また、図４の（Ｃ）に示す表面形状検出センサ４Ｄは、前記表面形状検出センサ４Ｂと同等の機能を有する。

【００１２】図５は、駆動・検出部のブロック図である。この図に示すように、駆動・検出部５は、交流信号を生成する正弦波発振器１５を備えており、その交流信号は、９０°移相器１６とパワーアンプ１７とに分岐される。パワーアンプ１７に入力された交流信号は、増幅されて励磁コイル３ａ、３ｂに印加される。一方、各磁束変化検出素子６は、インピーダンス整合器１８に接続されており、ここでインピーダンスが整合された検出信号がマルチプレクサ１９に入力される。マルチプレクサ１９は、制御ロジック２０の指令で順次チャンネルが選択され、検出信号を同期検波回路２１に出力する。同期検波回路２１に入力された検出信号は、９０°移相器１６の信号を参照信号として同期検波される。同期検波回路２１の出力信号は、渦電流による磁束変化の渦電流損であり、選択された磁束変化検出素子６の対向位置における被検体２の表面勾配に比例した電圧出力である。この出力信号は、フィルタ２２を介してＡ／Ｄ変換器２３に入力され、ここでデジタル化された後、ＦＩＦＯメモリ２４（First-in First-out Memory）に順次格納される。格納された検出データは、表面形状可視化装置、表面欠陥検査装置、硬貨識別装置、表面文字・模様識別装置等の外部装置に受け渡される。制御ロジック２０は、マルチプレクサ１９やＡ／Ｄ変換器２３を制御しつつ検出データをＦＩＦＯメモリ２４に順次格納し、これを外部装置に送り出すシーケンス回路であり、マイコン等でも実現できる。

【００１３】図６は、表面形状可視化装置のブロック図である。この図に示すように、表面形状可視化装置２５は、前述した表面形状検出装置１と、該表面形状検出装置１から出力される検出データを表示信号に変換する信号変換部２６と、該信号変換部２６から出力される表示信号に応じて被検体２の表面形状を表示する表示器２７とを備えて構成される。信号変換部２６は、検出データ（表面形状検出センサ４）の配列をM行、N列、表示器２７の表示ピクセル配列をＸ、Ｙとし、各検出データの値をＢ（ｍ、ｎ）、表示器２７のピクセル輝度をＫ（ｘ、ｙ）としたとき、Ｂ空間からＫ空間へ補間して拡大写像するもので、例えば単純な繰返しのワイヤードロジックの他、マイコン等を用いたプログラム処理でも実現できる。また、色補間表示も、Ｒ、Ｇ、Ｂ（赤、緑、青）の輝度について同様の処理を行えば可能であり、これをＮＴＳＣ信号やＲＧＢ信号に変換することによって市販モニタに表面形状を表示することが可能になる。そして、本発明の表面形状可視化装置２５によれば、先に述べた原理に基づき、被検体２の表面に存在する凹凸が強調されて見えることから、被検体２の表面における欠損傷等を容易に発見することができ、しかも、光学式の表面形状検出装置を用いる場合に比べ、外部照明が不要になる許りでなく、外乱光や汚れによる影響を排除することが可能になる。

【００１４】図７は、表面文字・模様認識装置のブロック図である。この図に示すように、表面文字・模様認識装置２８は、前述した表面形状検出装置１と、該表面形状検出装置１から出力される検出データに基づいて被検体２の表面に刻印された文字や模様を識別する識別部２９とを備えて構成される。識別部２９は、検出データのノイズを除去するフィルタ３０と、検出データを所定の閾値を用いて２値化する２値化処理部３１と、２値化データのなかから認識エリアを特定する認識エリア特定部３２と、認識エリアが傾いている場合にマトリクス演算等でデータの回転操作を行うデータ補正部３３と、上記認識エリアを細かいセルに分割し、予め設定された参照パターンとマッチングするマッチング処理部３４と、そのヒット率（相関度数）に基づいて被検体２の表面に刻印された文字や模様を特定する文字・模様特定部３５と、その結果を出力する結果出力部３６とを備えて構成される。上記の処理は、ワイヤードロジックによるハード処理の他、マイコン等を用いたプログラム処理でも実現できる。

【００１５】図８は、表面欠陥検査装置に設けられる表面形状検出装置の斜視図、図９は、表面欠陥検査装置のブロック図である。これらの図に示すように、表面欠陥検査装置３７は、被検体２の表面形状を検出する表面形状検出装置３８と、該表面形状検出装置３８から出力される検出データに基づいて被検体２の表面に存在する傷等の欠陥を自動検査する自動検査部３９とを備えて構成される。表面形状検出装置３８は、一対の励磁コイル４０ａ、４０ｂを備える交流磁界発生装置４０と、１次元配列された複数の磁束変化検出素子（図示せず）を備える表面形状検出センサ４１と、これらを一体的に支持する支持プレート４２とを備えて構成されており、被検体２の表面に沿って手動もしくは自動で搬送される。自動検査部３９は、検出データのノイズを除去するフィルタ４３と、検出データを所定の閾値を用いて２値化する２値化処理部４４と、２値化データのなかから認識エリアを特定する認識エリア特定部４５と、上記認識エリアを細かいセルに分割し、予め設定された参照パターンとマッチングするマッチング処理部４６と、そのヒット率（相関度数）に基づいて被検体２の表面に存在する傷等

の欠陥を特定する欠陥特定部４７と、その結果を出力する結果出力部４８とを備えて構成される。上記の処理は、ワイヤードロジックによるハード処理の他、マイコン等を用いたプログラム処理でも実現できる。また、前記表面形状可視化装置２５を併用すれば、被検体２の表面をモニターしながら欠陥検査を行うことができ、欠陥検査の精度を高めることが可能になる。

【００１６】図１０は、硬貨識別装置に設けられる表面形状検出装置の斜視図、図１１は、硬貨識別装置のブロック図、図１２は、磁束変化検出素子（　）の配置を示す図、図１３は、ｊ行の磁束変化を示す（　）ある。これらの図に示すように、硬貨識別装置４９は、被検体である硬貨５０の表面形状（表裏）を検出する表面形状検出装置５１と、該表面形状検出装置５１から出力される検出データに基づいて硬貨５０の種類や真偽を識別する硬貨識別部５２とを備えて構成される。表面形状検出装置５１は、硬貨搬送路５３を囲むように配置された一対の励磁コイル５４ａ、５４ｂを備える交流磁界発生装置５４と、２次元配列された複数の磁束変化検出素子５５を備え、かつ、各磁束変化検出素子５５が、交流磁界発生装置５４の発生磁界および硬貨５０の表裏面に沿うように貨幣搬送路５３を挟んで配置された一対の表面形状検出センサ５６とを備えて構成される。硬貨識別部５２は、検出データのノイズを除去するフィルタ５７と、検出データから硬貨５０の外径成分Ｄを抽出する外径抽出部５８と、検出データから硬貨５０の導電率・厚み成分ｔ／ρ（ｔは厚み、ρは比抵抗率）を抽出する導電率・厚み抽出部５９と、種類判定テーブル（硬貨毎の外径成分Ｄおよび導電率・厚み成分ｔ／ρを記憶する領域）を参照し、前記抽出した外径成分Ｄおよび導電率・厚み成分ｔ／ρに対応する硬貨５０の種類Ｋｎを特定する種類判定部６０と、検出データを所定の閾値を用いて２値化する２値化処理部６１と、２値化データを細かいセルに分割し、上記種類Ｋｎに対応する参照パターンとマッチングするマッチング処理部６２と、そのヒット率（相関度数）に基づいて硬貨５０の真偽を判定する真偽判定部６３と、その結果を出力する結果出力部６４とを備えて構成される。即ち、硬貨５０の種類をＫｎとすると、種類Ｋｎを規定する諸量は、硬貨５０の外径Ｄ、厚みｔ、重さＷ、材質に依存する導電率σ（σ＝１／ρ）等であり、そのうち、外径Ｄは、図１３に示すように、検出データ（硬貨中心を通る行データ）における最初と最後のピークを認識し、その間のセル数をカウントすることにより算出される。一方、厚みｔおよび導電率σは、磁束変化検出素子５５によって検出される渦電流損失Ｐｅが、

$$Pe = k\{(D^2 t \omega^2)/\rho\}$$　　（ωは周波数）

であることから、磁束変化検出素子５５の検出データのみでは分離が難しい（導電率検出用センサを別途設ければ分離は容易）。そこで、本実施形態においては、検出データから導電率・厚み成分ｔ／ρを抽出し、該導電率・厚み成分ｔ／ρと前記外径成分Ｄを用いて硬貨５０の種類を判定している。つまり、これらの諸量と、種類判定テーブルに設定される硬貨毎の諸量データとが許容誤差の範囲で一致するとき、その種類Ｋｎの参照パターンと、検出データをセル分解したビットマップデータとをマッチングし、そのヒット率が許容範囲に入るとき、真貨であると判定し、それ以外を偽貨と判定する。尚、上記参照パターンは、硬貨５０の種類毎に表面用参照パターンと裏面用参照パターンとが用意される。また、上記マッチング処理は、上記ビットマップデータもしくは参照パターンを所定ピッチで回転させながら複数回実行され、硬貨５０の回転角に影響を受けない真偽判定が行われる。

【００１７】叙述の如く構成されたものにおいて、導体からなる被検体２の表面形状を検出する場合、前記被検体２の表面に略平行な交流磁界を発生させる交流磁界発生工程と、前記被検体２の表面近傍で前記磁界に略平行な向きの磁束変化を検出する磁束変化検出工程とが実行される。つまり、被検体２の表面に略平行な交流磁界を発生させることにより、被検体２の表面に存在する凹凸の側面に渦電流を集中的に発生させ、該渦電流の発生状況を、前記磁界に略平行な向きの磁束変化として検出するので、被検体２の表面に存在する凹凸を明確に検出することが可能になり、その結果、凹凸の高さ変化に基づく僅かな磁束変化を検出していた従来に比べ、検出精度を飛躍的に向上させることができる。

【００１８】また、前記被検体２を、その表面に略平行な方向に移動させながら磁束変化を検出するようにした場合には、被検体２の表面形状をスキャニングすることができるため、少ない磁束変化検出素子６で被検体２の表面形状を特定することでき、しかも、検出時に被検体２側を移動させることにより、表面形状検出装置１の構造を簡略化することができる。

【００１９】また、前記被検体２の表面近傍で前記磁界に略平行な向きの磁束変化を検出する磁束変化検出素子６を、前記被検体２の表面に略平行な方向に移動させながら磁束変化を検出するようにした場合も、被検体２の表面形状をスキャニングすることができるため、少ない磁束変化検出素子６で被検体２の表面形状を特定することでき、しかも、検出時に磁束変化検出素子６側を移動させることにより、固定物の表面形状も検出することが可能になる。

【００２０】また、前記被検体２の移動方向、もしくは磁束変化検出素子６の移動方向に対して略直交し、かつ、前記被検体２の表面に沿う方向に１次元配列された複数の検出位置で磁束変化を検出するようにした場合には、１次元配列された磁束変化検出素子６によって、２次元の検出データを得ることができる。

【００２１】また、前記被検体２の表面に沿う方向に２

次元配列された多数の検出位置で磁束変化を検出するようにした場合には、被検体２の表面形状を、スキャニングすることなく検出できるため、被検体２もしくは磁束変化検出素子６の移動誤差に起因する検出誤差を回避し、検出精度を向上させることができる。

【００２２】また、表面形状検出センサ４は、その表面に略平行な交流磁界が発生された被検体２の表面近傍に配置され、前記磁界に略平行な向きの磁束変化を検出する磁束変化検出素子６を備えて構成されるため、前記方法による精度の高い表面形状検出を行うことができる。

【００２３】また、前記表面形状検出センサ４においては、磁束変化検出素子６が前記被検体２の表面に対して略平行に配置されるため、被検体２の表面に略平行な向きの磁束変化を精度良く検出することができる。

【００２４】また、前記表面形状検出センサ４において、磁束変化検出素子６を、前記被検体２の表面に沿う方向に１次元配列した場合には、被検体２もしくは磁束変化検出素子６を、磁束変化検出素子６の配列方向に対して略直交方向に移動させることにより、２次元の検出データを得ることができる。

【００２５】また、前記表面形状検出センサ４において、磁束変化検出素子６を、前記被検体２の表面に沿う方向に２次元配列した場合には、被検体２の表面形状を、スキャニングすることなく検出できるため、被検体２もしくは磁束変化検出素子６の移動誤差に起因する検出誤差を回避し、検出精度を向上させることができる。

【００２６】また、前記表面形状検出センサ４において、磁束変化検出素子６を、コイル、チップインダクタ、ホール素子もしくは磁気抵抗素子とした場合には、既存の磁気デバイスを利用して表面形状検出センサ４を構成することができる。

【００２７】また、前記表面形状検出センサ４において、連続状に形成されたコア１２と、該コア１２に所定間隔を存して巻回される複数のコイル１４とを用いて磁束変化検出素子ユニット１１を構成した場合には、１次元配列された複数の磁気変化検出素子を、効率よく製造できる許りでなく、部品点数や製造工程を削減して大幅なコストダウンを図ることができる。

【００２８】また、表面形状検出装置１は、前記被検体２の表面に略平行な交流磁界を発生させる交流磁界発生装置３と、前記被検体２の表面近傍で前記磁界に略平行な向きの磁束変化を検出する表面形状検出センサ４とを備えて構成されるため、前記方法を用いた精度の高い表面形状検出を行うことができる。

【００２９】また、硬貨識別装置４９は、前記表面形状検出方法（表面形状検出装置）を用いて硬貨５０の表面形状を検出した後、検出した表面形状データを、予め設定された参照パターンとマッチングし、そのヒット率に基づいて前記硬貨５０を識別するため、精度の高い表面形状データに基づき、硬貨５０を精度良く識別することができる。

【００３０】また、表面欠陥検査装置３７は、前記表面形状検出方法（表面形状検出装置）を用いて被検体２の表面形状を検出した後、検出した表面形状データを、予め設定された参照パターンとマッチングし、そのヒット率に基づいて前記被検体２の表面欠陥を判定するため、精度の高い表面形状データに基づき、被検体２の表面欠陥を精度良く判定することができる。

【００３１】また、表面形状可視化装置２５は、前記表面形状検出方法（表面形状検出装置）を用いて検出した被検体２の表面形状データを、表示器２７の表示信号に変換する信号変換部２６を備えるため、精度の高い表面形状検出データに基づき、被検体２の表面形状を精度良く表示することができる。

【図面の簡単な説明】

【図１】表面形状検出装置の概略断面図である。

【図２】空心コイルで構成された磁束変化検出素子の側面図である。

【図３】（Ａ）は磁束変化検出素子が１次元配列された表面形状検出センサの平面図、（Ｂ）は磁束変化検出素子が２次元配列された表面形状検出センサの平面図である。

【図４】（Ａ）は磁束変化検出素子ユニットを示す表面形状検出センサの側面図、（Ｂ）は単一の磁束変化検出素子ユニットを用いて構成される表面形状検出センサの平面図、（Ｃ）は複数の磁束変化検出素子ユニットを用いて構成される表面形状検出センサの平面図である。

【図５】駆動・検出部のブロック図である。

【図６】表面形状可視化装置のブロック図である。

【図７】表面文字・模様認識装置のブロック図である。

【図８】表面欠陥検査装置に設けられる表面形状検出装置の斜視図である。

【図９】表面欠陥検査装置のブロック図である。

【図１０】硬貨識別装置に設けられる表面形状検出装置の斜視図である。

【図１１】硬貨識別装置のブロック図である。

【図１２】磁束変化検出素子（セル）の配置を示す図である。

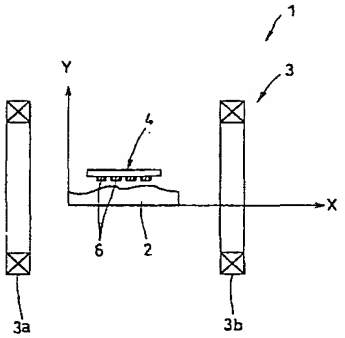
【図１３】ｊ行の磁束変化を示す図である。

【符号の説明】

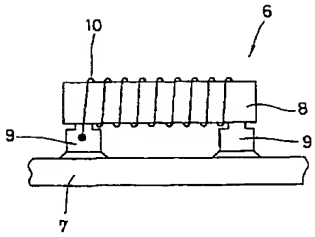
１　表面形状検出装置
２　被検体
３　交流磁界発生装置
３ａ　励磁コイル
３ｂ　励磁コイル
４　表面形状検出センサ
５　駆動・検出部
６　磁束変化検出素子
７　基板
８　コア

９　　電極部
１０　コイル
１１　磁束変化検出素子ユニット
１２　コア
１３　電極部
１４　コイル
２５　表面形状可視化装置
２８　表面文字・模様認識装置
３７　表面欠陥検査装置
３８　表面形状検出装置
４０　交流磁界発生装置
４１　表面形状検出センサ
４９　硬貨識別装置
５０　硬貨
５１　表面形状検出装置
５２　硬貨識別部
５３　硬貨搬送路
５４　交流磁界発生装置
５５　磁束変化検出素子
５６　表面形状検出センサ

【図１】



【図２】



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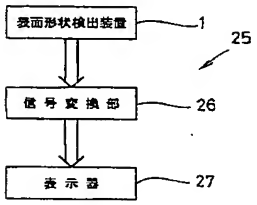
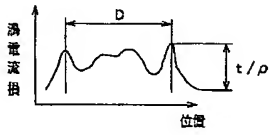
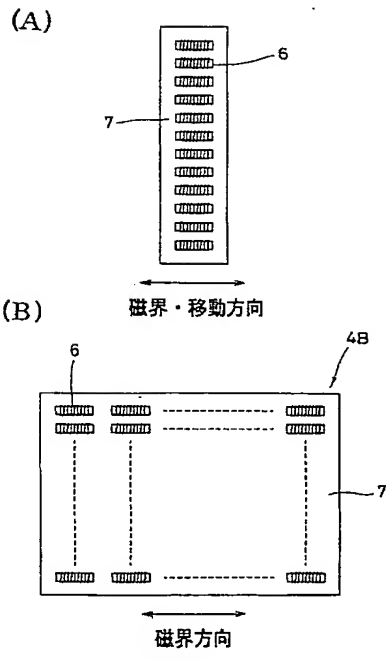


【図１３】



【図３】



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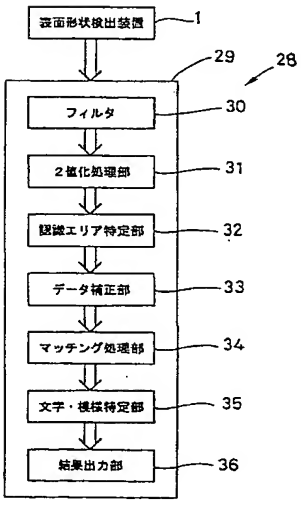

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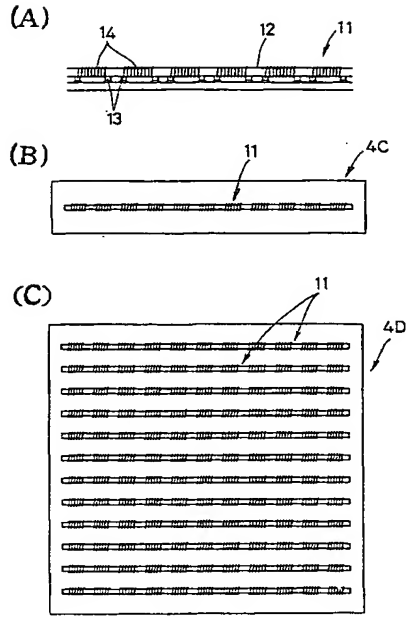

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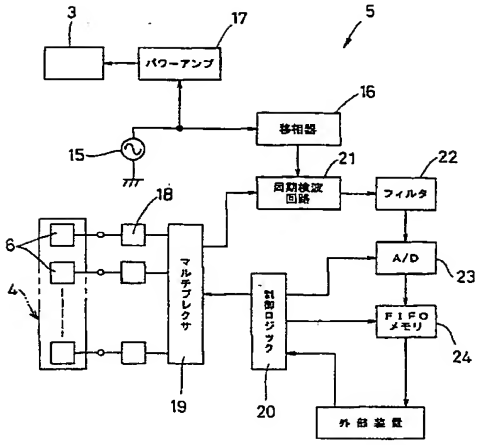

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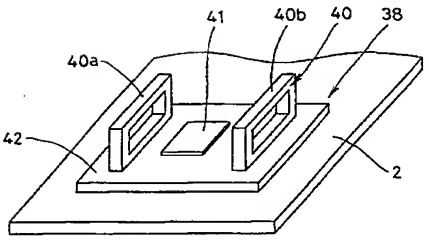

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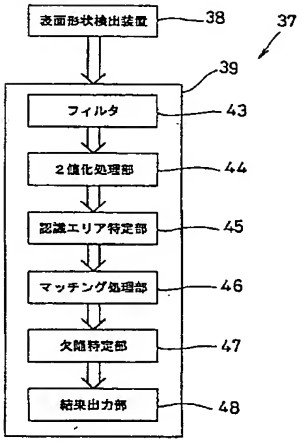
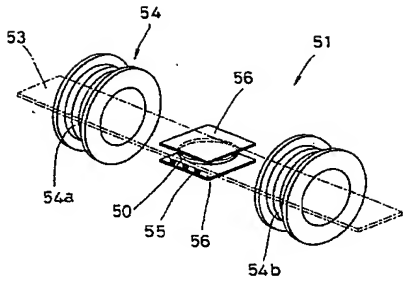


【図１０】



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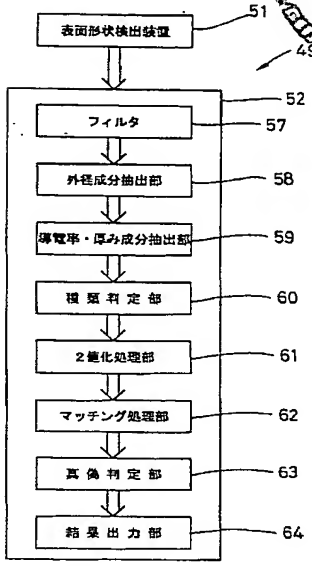
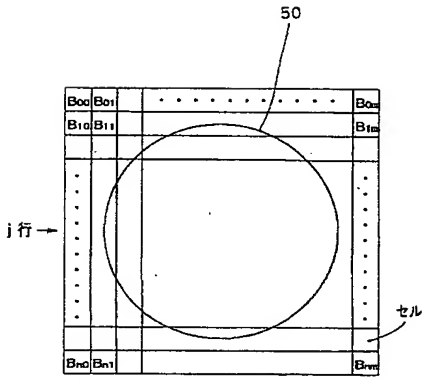


【図１２】



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CA06 EA05

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